

the Prince of Wales, and under State recognition, with the co-operation of the Worshipful Company of Fishmongers. At a private meeting held in July, 1881, it was determined by a few leading gentlemen, interested in the welfare of the great fishing industries, to follow up the National Fisheries Exhibition at Norwich by calling a public meeting in order to discuss the desirability of holding an International Fisheries Exhibition in London in 1883. A meeting was accordingly held at Fishmongers' Hall in August, 1881, under the presidency of the Marquis of Exeter, and Resolutions were unanimously passed approving the idea as likely to be of the greatest benefit and importance to fishing industries throughout the world. A General and Executive Committee were then formed, and great progress has since been made in preliminary arrangements.

The Committee, we are assured, have bestowed long and anxious consideration on the prospectus of the proposed Exhibition. The classification, which has been compiled with the assistance of leading scientific men, comprises every object adapted for exhibition, illustrative of Sea and Fresh Water Fisheries; the preparation, preservation, and utilisation of Fish; Fish Culture; the Natural History of Fish, and Literature connected with Fishing. It is proposed to give prizes on important subjects connected with fishing; and, with a view of turning the Exhibition to practical account, conferences are to be held for the purpose of reading and discussing subjects specially connected with the fishing industries. The Exhibition is to be opened on the 1st of May, 1883. In order to illustrate the great extent and magnitude of the fishing industries of the United Kingdom, it may be stated that, at the lowest calculation, 550,000 tons of fish are annually taken in British waters by our own fishermen; that, according to Professor Huxley, 3,000,000,000 herrings are annually taken in the North Sea alone; that 130,629 tons of fish were delivered in Billingsgate Market in one year; and that the fisheries of the United Kingdom are carried on by about 35,000 boats and vessels, giving employment to no less than 110,000 people afloat.

To carry out the proposed Exhibition on an adequate scale, it is proposed to open immediately a subscription list for the general and prize fund, and also a subscription list for a guarantee fund, to provide against contingent liabilities in the event of the proceeds of the Exhibition proving insufficient to meet the expenditure. The Fishmongers' Company have already promised the sum of 500*l.* for the general and prize fund, and 2,000*l.* to the guarantee fund.

The Exhibition will be divided into seven classes, each with many subdivisions:—I. Fishing, in two sections, Sea Fishing and Freshwater Fishing; II. Economic Condition of Fishermen; III. Commercial and Economic; IV. Fish Culture, which will include sections devoted to Scientific Investigation and Acclimatisation of Fish; V. Natural History under the following departments:—1. Specimens living (marine and fresh water), fresh, stuffed or preserved, casts, drawings and representations of—(a) Algae arranged according to their various species and localities; (b) Sponges, in their natural state; (c) Corals, in their natural state, polyps, jelly-fish, &c.; (d) Entozoa; (e) Mollusca of all kinds and shells not included in class III.; (f) Starfishes, sea urchins, holothuriæ; (g) Worms used for bait, or noxious; leeches, &c.; (h) Perfect insects and larvae of insects, which are destroyers of spawn or serve as food for fish; (i) Crustacea of all kinds; (k) Fish of all kinds; (l) Reptiles, such as tortoises, turtles, terrapins, lizards, serpents, frogs, newts, &c.; (m) Aquatic and other birds hostile to fish or fishing; (n) Aquatic and amphibious mammalia (otters, seals, whales, &c.) and others detrimental to fish. 2. Works on Ichthyology. Maps illustrating geographical distribution, migration, &c., of fishes and spawn. 3. Specimens and representations illustrative of the relations

between extinct and existing fishes. VI. History and literature of fishing, fishing laws, fish commerce. VII. Loan collections. This certainly seems comprehensive enough.

According to a preliminary notice Prizes of 100*l.* will be given for each of the following subjects, viz.:—1. The natural history of commercial fishes of Great Britain, with especial reference to such parts of their natural history as bear upon their production and commercial use. 2. Relations of the state with fishermen and fisheries, including all matters dealing with their production, regulations, &c. 3. On the possible increase of the supply of fish, and on improved facilities for their economic transmission and distribution.

All the speakers at Willis's Rooms on Monday seemed duly impressed with the importance of the Exhibition; and it was evident from their speeches that the Prince of Wales and Duke of Edinburgh take a genuine and intelligent interest in the matter. The statistical and economical sides of the proposed Exhibition were naturally more prominent before the meeting than the scientific, though the composition of the committee is a guarantee that the latter will have full attention. The Prince of Wales's reference to Prof. Huxley, and the plan of exhibits given above, may be taken as significant that these will not be neglected. There is plenty of time to make all arrangements and find a proper *locale*, and, probably enough, the committee may find it necessary to make some modifications in their arrangements. We are glad to see that the Prince of Wales is acquainted with the important work in fish-culture which is being done in the United States, which, we trust, will be fully represented at the Exhibition.

It may be useful to our readers to know that the offices of the Exhibition are at 24, Haymarket.

#### THE CHEMISTRY OF THE ATLANTIC<sup>1</sup>

##### II.

IN considering the effect of depth on the gaseous contents of sea water, Dr. Tornoe arranges his results in groups, giving the mean percentage of oxygen in different intervals of depth. From the consideration of this table he concludes that "the proportion of oxygen, which at the surface is 35·3 per cent., begins at once and continues to diminish, at first rapidly and afterwards at a slower rate, till it has reached 32·5 per cent. at the depth of 300 fathoms, from whence it keeps almost constant. I will not omit, however, to observe that of the samples of water examined, forty had been drawn from the bottom; it was, however, impossible to detect any difference in composition between these and the samples obtained from equal intermediate depths."

The results of the analysis of the *Challenger* samples pointed to a very decided minimum of oxygen occurring about 300 fathoms from the surface. The observations on which this conclusion depended were the analyses of the gases from two samples of water from 300 fathoms in the region of equatorial calms in the Atlantic. The temperature of the water was 7·0° C. and 6·8° C., and the oxygen percentages 10·75 and 11·98. The nearest part of the ocean where a surface temperature of 7° C. occurs at any time of the year is more than 2000 miles distant, so that the water in this position must necessarily have been shut out from a fresh supply of oxygen for a long time while continually exposed to the reducing action of live and dead animal matter. In the Arctic waters explored by the Norwegian Expedition there must be a tolerably thorough equalisation of temperature from surface to bottom every winter, producing a renewal of the atmospheric contents of the water, consequently it is not surprising that the

<sup>1</sup> The Norwegian North Atlantic Expedition, 1876-78. Chemistry. By Hercules Tornoe. (Christiania: Grondal and Son, 1880.) Continued from p. 389.

differences observed both by the Norwegian Expedition and by Jacobsen in the aération of water from different depths are so slight. Indeed, the *Challenger* analyses show exactly the same result for Antarctic waters. As the amount of nitrogen is probably not exposed to diminution, it may be taken as an indication of the temperature at which the water was last exposed to the air, and may therefore be used as a check on the depth from which the water has been brought, more especially in tropical regions, where the temperature at the surface is very different from what it is either at the bottom or intermediate depths. For this purpose, however, we require more observations on the absorption of atmospheric gases by sea water, especially at low temperatures; and, further, any conclusions drawn must be inaccurate, in so far as we do not know the barometric pressure of the atmosphere to which the water has been exposed. This is a very important element, for the water at the surface of the Antarctic Ocean is exposed to a much lower mean barometric pressure than at any other part of the globe, whether Arctic, Temperate, or Tropical, consequently a carefully-made determination of the nitrogen in a bottom water would, when taken in connection with the temperature, indicate whether it came from Arctic or Antarctic sources. This difference would certainly amount to 1 cc. per litre, which could easily be determined with careful work.

The great value of the results obtained by Dr. Tornoe in this department of his work make it all the more to be regretted that through mechanical mishaps so many samples, involving much time and work, should have been lost.

The form in which the results are presented to the reader might be improved by the addition of one or two columns to the table. It includes the analyses of samples collected in the three summers, 1876, 1877, and 1878, and it would have been more useful to the reader to have found the date of collection in the first column than a series of consecutive numbers. The second column is the "Station No.," and it is important as facilitating reference to other results obtained at the same place. By its means the writer was enabled to refer to Prof. Mohn's papers in *Petermann's Mittheilungen*, and from them to supply a column giving the depth of the sea at the station. The omission of this information from the table made it impossible to distinguish between bottom water and water from intermediate depths. Another column might also with advantage have been added, giving the volume of oxygen in cubic centimetres per litre.

In the second chapter of the work Dr. Tornoe treats of the carbonic acid dissolved in sea-water, and here also he adds very materially to our knowledge. The first reliable information on the subject was obtained by Jacobsen on board the *Pomerania*. He rejected the gasometric method, having recognised the uncertainty which attached to the elimination of the carbonic acid from sea water by boiling under reduced pressure and adopted the method of determining the carbonic acid directly, as soon as the sample of water was brought on board, by boiling it down nearly to dryness, and drawing a current of air through it, which conveyed the steam and carbonic acid into a suitable receiver charged with baryta water. In the *Challenger* substantially the same method was employed, with this important addition, that an excess of a saturated solution of chloride of barium was added to the water before distilling. By precipitating the sulphates, their effect in reducing the tension of the carbonic acid was destroyed, and also the liquid was got into a condition in which it boiled calmly, without bumping, until almost quite dry. The object aimed at was the determination of the carbonic acid present in the water in the free or *half-bound* state, to the exclusion of that present as neutral carbonate. There is no doubt that this was successfully accomplished, and the experi-

ments made by Dr. Tornoe furnish satisfactory evidence. "In order to ascertain whether the decomposition by boiling of the neutral carbonates in sea-water also took place to a considerable extent when insoluble sulphates were present in that fluid, I made a few experiments by Buchanan's process. From several samples of sea-water, which, examined by the method I adopted, were found to contain 96 mgr. of carbonic acid per litre, I succeeded by evaporation to dryness, after adding a solution of chloride of barium, in liberating about 50 mgr. only, with a solitary exception, when the amount exceeded 50 mgr. per litre. The proportion of carbonic acid expelled was accordingly not much greater than that determined by Buchanan in water from equatorial seas, and but a few milligrammes in excess of what the carbonic acid forming bicarbonates, according to trustworthy observations, should have been; of the carbonates said to be present in the residue I failed to detect any trace." This experiment shows that what was sought was really obtained, namely, the determination of the carbonic acid *not* present as neutral carbonate.

The method finally adopted by Dr. Tornoe is an exceedingly ingenious one, and has the great advantage of giving both the free and the bound carbonic acid. It consists in adding to the sample of water a measured quantity of acid of known strength, driving off the liberated carbonic acid by gentle heating, and collecting it in baryta water of known strength. When the operation is finished, the excess of acid in the boiling flask and the excess of alkali in the receiver are separately determined. The amount of baryta neutralised gives the total carbonic acid, while the amount of acid neutralised gives the amount present as neutral carbonate.

It does not seem to have occurred to Dr. Tornoe that his method of determining the carbonic acid might be combined with the boiling out of the oxygen and nitrogen. If to the sample from which the gases are to be extracted by boiling under reduced pressure be added sufficient acid to more than neutralise the carbonates, and the boiling be then continued as if for the elimination of the oxygen and nitrogen, the whole of the carbonic acid should be obtained along with these gases, while the excess of acid in the flask could be measured when the operation was finished. This process would have the advantage that oxygen, nitrogen, and carbonic acid would be collected in one operation. It would be necessary to make the tube in which the gases are to be preserved larger than is at present usual, but a volume of 100 cubic centimetres would suffice for a volume of 800 or 900 cubic centimetres water.

By this method the carbonic acid was determined in seventy-eight samples of water from different parts. It is somewhat of a pity that the determinations were not made on board when the samples were fresh, though there is no doubt that in the case of sea waters which contain only traces of organic matter, the amount of carbonic acid is not sensibly affected by keeping. The results obtained are very uniform, and he gives the following average formulæ:—

$$52.78 \pm 0.83 \text{ mgr. per litre}$$

for the carbonic acid forming carbonates with a probable error in a single observation of  $\pm 0.662$  per litre; and

$$43.64 \pm 0.16 \text{ mgr. per litre}$$

for the carbonic acid, forming bicarbonates with a probable error in a single observation of  $\pm 1.26$  mgr. per litre."

Touching the uniformity of these results, it must be observed that the samples would probably be all at nearly the same temperature when examined, while they would be collected at different and lower temperatures. Hence the fact of keeping would tend to produce uniformity in the results. Hence also there is no mention of temperature in his average formulæ. Now although the law regulating the absorption of carbonic acid by sea water at

different temperatures cannot be precisely stated, the *Challenger* results leave no doubt that more carbonic acid is absorbed the lower the temperature is. Taking the mean of all the *Challenger* determinations in surface water at temperatures between 10° C. and 15° C., we have 43.5 mgr. per litre of carbonic acid liberated by boiling to nearly dryness after precipitation of the sulphates; and this agrees to a fraction of a milligram with Tornoe's average amount of carbonic acid present as bicarbonate.

Dr. Tornoe concludes this part of the work with an interesting inquiry into the condition in which the carbonic acid exists in the water, and comes to the conclusion that it is probably present in combination with soda, forming bicarbonate of soda.

In the third portion of his work Dr. Tornoe gives an account of his experiments on the amount of salt held in solution by the sea water. For determining it he follows two methods, the one depending on the specific gravity, and the other on the chlorine contained in the water. The specific gravity was determined by means of suitable glass hydrometers, and the chlorine by means of silver solution of known strength. In order to reduce the specific gravities which were observed at various temperatures to their value at one standard temperature, Dr. Tornoe reports an elaborate series of experiments on the expansion of sea water due to change of temperature, and he uses the result too obtained along with those of Ekman for reducing results. They are given in two columns; in one is the specific gravity at 17.5° C. referred to that of distilled water at the same temperature as unity; in the other they are reduced to their value at the temperature of the water when *in situ*, referred to distilled water at 4° C. as unity.

In order from these results to arrive at a knowledge of the amount of solid matter dissolved, he makes a series of careful determinations of solid residue of chlorine and of specific gravity in seven samples of water. He finds that "the co-efficient of chlorine may be taken at

$$1.809 \pm 0.00076$$

with a probable error in a single determination of  $\pm 0.002$ , and the co-efficient of specific gravity at—

$$1.319 \pm 0.058$$

with a probable error in a single determination of  $\pm 0.15$ . The specific gravity is here taken at 17.5° C., and the unit is that of distilled water at the same temperature.

The determination of the solid residue in sea-water presents special difficulties due to the presence of so large amounts of magnesia salt. These difficulties are overcome in an ingenious way:—"From 30 gr. to 40 gr. of sea-water were introduced into a thick porcelain crucible of known weight furnished with a tight-fitting cover, and evaporated on a water-bath. So soon as the salt was sufficiently dry the crucible with the cover on was heated for about five minutes over one of Bunsen's gas-burners, then cooled and weighed with its contents."

The free magnesia liberated by this process was then determined by dissolving the salt and adding a quantity of titrated sulphuric acid and determining what remained unneutralised by titrating with caustic soda.

The results so obtained are given in a table, and also represented graphically in charts at the end of the work. These charts show very clearly the distribution of the water from the Atlantic amongst that coming from Polar regions, which is also confirmed not only by the temperatures observed, but also by the distribution of nitrogen dissolved in the bottom water, of which Dr. Tornoe has given a chart. It is well known that the water coming up from the North Atlantic is much saltier than that coming south from the Arctic and Polar regions. From the variations in the amount of salt found in the bottom water of different districts Dr. Tornoe suspected that some of it must be due to the presence of Atlantic water which had got cooled on its way north,

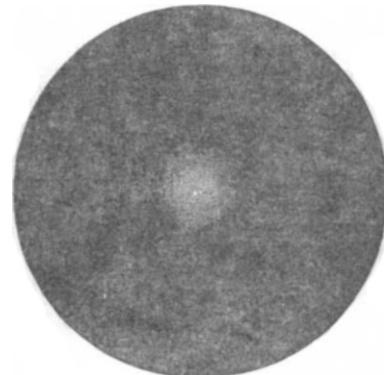
and had sunk to the bottom. It is in the highest degree probable that the nitrogen found dissolved in a sea-water, taken from any depth, is the nitrogen which it took up when last exposed to the atmosphere. Now the amount of nitrogen which it would take up would depend to a great extent on the temperature, so that water which had been exposed at the surface in Arctic regions would take up more nitrogen than water which had been exposed in temperate regions, so that the amount of nitrogen present, for instance, in a bottom water, may be taken to indicate the temperature which the water had when last exposed to the atmosphere. Now it is a remarkable result of Dr. Tornoe's investigations that where he finds a high percentage of salt in the bottom water he also finds a low percentage of nitrogen, and *vice versa*, rendering it in every way probable that the areas which he has mapped out are really supplied on the one hand from the Atlantic, and on the other from the Arctic Oceans. This result is a further evidence of the importance of accurate determinations of the gaseous contents of sea-water.

It is impossible to conclude this notice without congratulating the Norwegian nation on the advanced position which it has taken up in ocean exploration and the success which has attended the labours of its servants, and in an especial way of Prof. Mohn and those associated with him in the three summer trips of 1876, 1877, and 1878. Not only is the work done great in amount and of the highest scientific interest, but it has been published with a praiseworthy expedition which adds immensely to its present value.

J. Y. BUCHANAN

#### COMET f 1881

ON the morning of October 4, 1881, while engaged in sweeping the eastern sky for new comets, I found an object about 10 degrees preceding a Leonis on the ecliptic which bore a strong resemblance to a bright round nebula, with a marked condensation in the centre. I roughly estimated the position of the object, and referring to Herschel's catalogue of nebulae, endeavoured to identify it, but without success. Then carefully noting its place relatively to the small stars in the same field of my



Comet f 1881, October 3, 15h. 15m.; 10-inch reflector, power 25.

10-inch reflector, I resumed sweeping in the region near. About half an hour later—3 45 a.m.—I re-observed the object, as clouds were rapidly coming up. A slight motion to the eastward was at once suspected to have occurred in the interval, but my positions were merely eye estimations, and I distrusted them though feeling certain at the time that the supposed displacement was real. I had only obtained a momentary glimpse when the sky became completely overcast, but fortunately the ensuing night was cloudless, and I was enabled to obtain another observation. The suspected object did not rise until soon after 1 a.m., and I knew that it would not come under the